

REMARKS

Reconsideration of the present application is respectfully requested.

Applicant notes with appreciation the acknowledgement of the claim for priority under 35 U.S.C. §119(b) and the notice that all of the certified copies of the priority documents have been received.

Applicant also appreciates receiving a copy of form PTO-1449, on which the Examiner has initialed each listed reference.

The Examiner has not acknowledged receipt and approval of the formal drawings that were submitted on October 30, 2001. Express acknowledgement of these formal drawings is respectfully requested.

In addition, a proposed change to the drawings, namely FIG. 9, is being submitted herewith along with a separate letter to the draftsman. This change corrects a minor error noticed by the Applicant and in no way adds new matter to the drawings.

Applicant has amended the specification to correct minor inconsistencies and translation errors. Applicant respectfully asserts that no new matter has been added as the changes were made only to provide a clearer description of Applicant's disclosed invention.

Claims 1-15 have been rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,121,011 to Ohya et al. (Ohya). Applicant respectfully traverses this rejection.

Ohya discloses an analog device driver circuit including MOS transistors Tr1 and Tr2 connected in series between two voltage sources Vcc and Vee. MOS transistor Tr1 is driven by bipolar transistors Tr3 and Tr4 (high- and low-side switching circuits, respectively) that are connected at output n1 in series between Vcc and Vee. MOS transistor Tr2 is driven by transistors Tr5 and Tr6 that are connected at output n2 in series between Vcc and Vee. In this

configuration, the first MOS transistor Tr1 is designed to be off when the second MOS transistor Tr2 is on and vice versa. As shown in Fig. 4, voltage dividers DIV1 and DIV2 and transistors TC₃ and TC₄ may be used to provide additional protection against the first MOS transistor Tr1 and the second MOS transistor Tr2 being on simultaneously. Specifically, voltage dividers DIV1 and DIV2 and transistors TC₃ and TC₄ provide a delay when one of the MOS transistors Tr1, Tr2 is turned on to provide the other MOS transistor time to turn off.

The drive circuit of the present invention is designed to reduce current and power consumption and comprises a high-side switching circuit, a low-side switching circuit, and a voltage detector. The high-side switching circuit comprises the transistor T11 and the output control circuit 18. The low-side switching circuit comprises the transistor T12 and the output control circuit 19. The voltage detector 20 detects the output voltage, V_o, at an output defined at the junction of T11 and T12, which are connected in series between power supply lines 16 and 17. Depending on the output voltage V_o, transistors T11 or T12 may be turned off in order to reduce current and power consumption. In other words, if V_o is determined to be above a predetermined high threshold, the high-side switching circuit, which works to output a high voltage, is turned off. If V_o is determined to be below a predetermined low threshold, the low-side switching circuit, which works to output a low voltage, is turned off. Therefore, transistors T11 and T12 may be turned on for a minimal amount of time.

Regarding claim 1, Applicant respectfully asserts that Ohya fails to disclose all features of the present invention as recited in claim 1. For example, Ohya does not disclose a low-side switching circuit that is turned off when the voltage from an output voltage detector is lower than a predefined voltage. More specifically, in the drive circuit of claim 1, power can be saved and heat dissipation can be reduced by turning off the low-side switching circuit when the output is

determined to be low (page 17, line 7 – page 18, line 24 and Figs. 3 and 4 of present application). As can be seen in Fig. 4 of Ohya, transistor Tr4 (low-side switching circuit as defined by the Examiner) is not turned off when the voltage from DIV1 (voltage detector as defined by the Examiner) is lower than a predefined voltage. In fact, contrary to the Examiner's interpretation, the voltage detected at DIV1 is not even a factor in the operation of the transistor Tr4.

Therefore, as Ohya fails to disclose all features of Applicant's claim 1, Applicant respectfully requests that the rejection under 35 U.S.C. §102(b) of claim 1 be withdrawn.

Claims 2-5 depend directly or indirectly from claim 1. Applicant respectfully requests that the rejection under 35 U.S.C. §102(b) of claims 2-5 be withdrawn for the reasons discussed above in connection with claim 1.

Regarding claim 6, Ohya fails to disclose all features of the present invention as recited in claim 6. For example, Ohya does not disclose a high-side switching circuit that is turned off when the voltage from an output voltage detector is higher than a predefined voltage. Similarly to turning off the low-side switching circuit when the output is determined to be low as recited in claim 1, turning off the high-side switching circuit when the output is already high as recited in claim 6 saves power and reduces heat dissipation (page 26, lines 5-13 of the present application). As can be seen in Fig. 4 of Ohya, transistor Tr3 (high-side switching circuit as defined by the Examiner) is not turned off when the voltage from DIV1 is higher than a predefined voltage.

Therefore, as Ohya fails to disclose all features of Applicant's claim 6, Applicant respectfully requests that the rejection under 35 U.S.C. §102(b) of claim 6 be withdrawn.

Claims 7-10 depend directly or indirectly from claim 6. Applicant respectfully requests that the rejection under 35 U.S.C. §102(b) of claims 7-10 be withdrawn for the reasons discussed above in connection with claim 6.

Claim 11 recites the novel features disclosed in above-discussed claims 1 and 6. Specifically, claim 11 recites a low-side switching circuit that is turned off when the voltage measured at an output voltage detector is lower than a predetermined voltage, and a high-side switching circuit that is turned off when the voltage measured at an output voltage detector is higher than a predetermined voltage. Applicant respectfully asserts that Ohya fails to disclose all features of the present invention as recited in claim 11 for the above-discussed reasons in connection with claims 1 and 6.

Therefore, Applicant reasserts that Ohya fails to disclose all features of Applicant's claim 11, and respectfully requests that the rejection under 35 U.S.C. §102(b) of claim 11 be withdrawn.

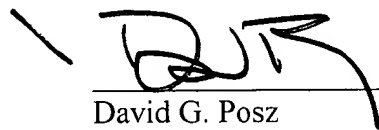
Claims 12-15 depend directly or indirectly from claim 11. Applicant respectfully requests that the rejection under 35 U.S.C. §102(b) of claims 12-15 be withdrawn for the reasons discussed above in connection with claim 11.

In view of the above amendments and remarks, the present application is now believed to be in condition for allowance. A prompt notice to that effect is respectfully requested.

A petition for a one-month extension of time along with a check for the requisite petition fee is being submitted concurrently with the present amendment. Although no additional fees are believed to be due, permission is given to charge any additional unforeseen fees to Deposit Account 50-1147.

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MARKED UP VERSION OF AMENDED SPECIFICATION

IN THE SPECIFICATION

Please replace the paragraph beginning on page 2, line 8 as follows.

Specifically, the drive circuit 1 is a push-pull circuit which is responsive to the control signal Sa of a low level inputted to the input terminal 2 to turn on the transistor $T1$ and off the transistors $T2$ and $T3$ so that the voltage Vb is applied from the power supply line 5 to the gate of the MOSFET [T4] 4 to turn on the MOSFET [T4] 4. When the control signal Sa of a high level is inputted to the input terminal 2, the transistors $T2$ and $T3$ are turned on, while the transistor $T1$ is turned off, so that the voltage of zero (0) at the ground line 6 is applied to the gate of the MOSFET [T4] 4 to turn off the MOSFET [T4] 4.

Please replace the paragraph beginning on page 3, line 6 as follows.

Between the gate and the source and between the gate and the drain of the MOSFET [T4] 4, capacitors C_{gs} and C_{gd} are usually provided, respectively. These gate capacitors are illustrated by broken lines in FIG. 10. Decreasing turning-on and -off time periods of the MOSFET [T4] 4 to achieve a rapid switching operation thereof requires an increased ability of the drive circuit 1 to produce a great current for charging and discharging the gate capacitors of the MOSFET [T4] 4 when required to be switched between the on-state and the off-state.

Please replace the paragraph beginning on page 3, line 15 as follows.

Accordingly, in the drive circuit 1, the base current of the transistor $T2$ is set to a great value for enabling the transistor $T2$ to withdraw as the collector current thereof the electric charge from the gate capacitors for a short time when the MOSFET [T4] 4 is switched from the on-state to the off-state. Additionally, the base current of the transistor $T1$ is set to a great value for enabling the transistor $T1$ to charge the gate capacitors of the MOSFET [T4] 4 for a short time with the collector current thereof when the MOSFET [T4] 4 is switched from the off-state to the on-state. The adjustment of these base currents [are] is achieved by regulating the resistance values of the resistors $R4$ and $R6$.

Please replace the paragraph beginning on page 3, line 26 as follows.

The base current of the transistor $T2$ inputted from the power supply line 5 through the resistor $R6$ and the transistor $T4$ continues to flow not only when the transistor $T2$ is switched between the on- and off-states, but also during a steady-state operation in which the transistor $T2$ is in the on-state (i.e., the MOSFET [T4] 4 is in the off-state). An increase in base current of the transistor $T2$ for shortening the turning-off time period thereof, thus, causes the current consumption of the drive circuit 1 to increase, which results in an increase in quantity of heat generated by the resistors $R4$ and $R6$. This requires a decrease in guarantee ambient temperature of the IC in which the drive circuit 1 is located.

Please replace the paragraph beginning on page 4, line 19 as follows.

It is another object of the invention to provide a drive circuit whose [the] current and power consumption is decreased without sacrificing the switching speed of a switching element to be controlled by the drive circuit.

Please replace the paragraph beginning on page 5, line 9 as follows.

In the preferred mode of the invention, the high-side switching circuit includes an output transistor, a predriver driving the output transistor, a comparing circuit comparing the output voltage detected by the voltage detector with the on-decision voltage, and a logic circuit controlling an operation of the predriver [base] based on a result of comparison in the comparing circuit.

Please replace the paragraph beginning on page 7, line 21 as follows.

BRIEF [DESCPTION] DESCRIPTION OF THE DRAWINGS

Please replace the paragraph beginning on page 10, line 10 as follows.

The drive circuit 11 includes an output control circuit 18 for driving the transistor *T11*, an output control circuit 19 for driving the transistor *T12*, an *npn* transistor *T13* disposed between the input terminal 12 and an input terminal of each of the output control circuits [17] 18 and [18] 19, a constant current source *CS11*, and a voltage detector 20. The voltage detector 20 is disposed between the output terminal 13 and the ground line 17 and works to detect the voltage (i.e., the voltage signal *Vo*) appearing at the output terminal 13. The transistor *T11* and the output control circuit 18 function as a

high-side switching circuit. The transistor $T12$ and the output control circuit 19 function as a low-side switching circuit.

Please replace the paragraph beginning on page 11, line 3 as follows.

The drive circuit 11 also includes a high-side predriver 23 and a low-side predriver 24. The predriver 23 consists of a pnp transistor $[T22]$ $T21$, npn transistors $T22$ and $T23$, and resistors $R18$ to $R20$. The predriver 24 consists of a pnp transistor $T24$, npn transistors $T25$ and $T26$, and resistors $R21$ to $R24$.

Please replace the paragraph beginning on page 11, line 8 as follows.

The output control circuit 18 shown in FIG. 2 includes the logic circuit 21 and the predriver $[22]$ 23 . The output control circuit 19 shown in FIG. 2 includes the logic circuit 21, the comparator 22, and the predriver 24. Specifically, the logic circuit 21 is used both in the output control circuits 18 and 19.

Please replace the paragraph beginning on page 20, line 18 as follows.

The drive circuit 11 also includes the voltage detector 20 designed to detect the output voltage V_o (i.e., the gate voltage of the MOSFET 14) and the comparator 22 designed to compare the detected output voltage V_o with the off-decision voltage lower in level than the threshold value V_{th} of the MOSFET 14 and works to turn off the predriver 24 when the output voltage V_o is determined to be lower than the off-decision voltage to stop the supply of the base current to the transistor $T12$. Specifically, during a transitional period of time in which the MOSFET 14 is brought into the off-state, the

transistor *T12* is turned on, thereby causing the [MOSFEZT] MOSFET 14 to be turned off quickly. After the MOSFET 14 is turned off, the current flowing through the predriver 24 (including the base current of the transistor *T12*) is cut, thus resulting in a decrease in consumption of current and power in the drive circuit 11. As compared with the conventional drive circuit 1, the heat dissipation from the IC on which the drive circuit 11 is fabricated is decreased greatly without increasing the turning-on time as well as the turning-off time of the MOSFET 14. This allows the drive circuit 11 to be used in a high temperature environment and a large number of drive circuits equivalent to the drive circuit 11 to be built in an IC.

Please replace the paragraph beginning on page 21, line 12 as follows.

In the drive circuit 11, the longer the time in which the MOSFET 14 is in the off-state, the greater will be the current and power consumptions. The resistors *R25* and *R26* making up the voltage detector 20 work as pull-down resistors [acing] acting on the gate of the MOSFET 14. Therefore, even when the transistors *T11* and *T12* are turned off, the MOSFET 14 is kept off stably.

Please replace the paragraph beginning on page 25, line 21 as follows.

As apparent from the above discussion, the driver circuit 25 of the second embodiment has the voltage detector 30 designed to detect a potential difference between the power supply line 16 and the output terminal 13 (i.e., the output voltage *V_o* defined based on the potential at the power supply line 16) and the comparator 32 designed to compare the detected output voltage *V_o* with the off-decision voltage lower in level than

the threshold value V_{th} of the MOSFET 26 and works to turn off the predriver 23 when the output voltage V_o is determined to be lower than the off-decision voltage to stop the supply of the base current to the transistor $T11$. Specifically, during a transitional period of time in which the MOSFET 26 is brought into the off-state, the transistor $T11$ is turned on, thereby bringing the [MOSFEZT] MOSFET 26 into the off-state quickly. After the MOSFET 26 is turned off, the current flowing through the predriver 23 (including the base current of the transistor $T11$) is cut, thus resulting in a decrease in consumption of current and power in the drive circuit 25. The longer the time in which the MOSFET 26 is in the off-state, the greater will be the current and power consumptions.

Please replace the paragraph beginning on page 26, line 23 as follows.

The drive circuit 33 also includes the voltage detectors 20 and 30. In this embodiment, the voltage level determined by the right side of Eqs. (10) and (11) is the level of an on-decision voltage which lies within a voltage range in which the MOSFET 14 is turned on.[.]

Please replace the paragraph beginning on page 27, line 2 as follows.

Therefore, when the control signal S_a is changed in level for turning on the [MOSFEET] MOSFET 14, the drive circuit 33 turns on the transistor $T11$ on the high side. Alternatively, when the control signal S_a is changed in level for turning off the MOSFET 14, the drive circuit 33 turns on the transistor $T12$ on the low side. This charges or discharges the gate capacitors of the MOSFET 14 quickly.